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**D E C I S I O N**  
**of 15 September 2004**

**Case Number:** T 0970/00 - 3.4.2

**Application Number:** 96109616.1

**Publication Number:** 0749032

**IPC:** G02F 1/335

**Language of the proceedings:** EN

**Title of invention:**  
Acousto-optic deflector device

**Patentee:**  
MURATA MANUFACTURING CO., LTD.

**Opponent:**  
-

**Headword:**  
-

**Relevant legal provisions:**  
EPC Art. 56

**Keyword:**  
"Inventive step (yes) - ex-post facto assessment of the disclosure of the closest prior art"

**Decisions cited:**  
T 0967/97

**Catchword:**

Any attempt to interpret the disclosure of the closest prior art so as to distort or misrepresent, based on hindsight knowledge of the invention, the proper technical teaching of the disclosure in such a way that it artificially meets specific features recited in the claim under consideration must fail, especially as this would risk unfairly and tendentiously concealing the technical contribution of the invention and prejudice the subsequent objective determination of the technical problem solved by the claimed invention (point 4.1.2 of the Reasons).



Case Number: T 0970/00 - 3.4.2

**D E C I S I O N**  
of the Technical Board of Appeal 3.4.2  
of 15 September 2004

**Appellant:**

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**Representative:**

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**Decision under appeal:**

Decision of the Examining Division of the  
European Patent Office posted 16 June 2000  
refusing European application No. 96109616.1  
pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** A. G. Klein  
**Members:** F. J. Narganes-Quijano  
M. J. Vogel

## Summary of Facts and Submissions

- I. The appellant (applicant) lodged an appeal against the decision of the examining division to refuse European patent application No. 96 109 616.1 (publication No. 0 749 032).

In its decision the examining division held that the subject-matter of claim 1 according to the main and first and second auxiliary requests then on file did not involve an inventive step (Articles 52(1) and 56 EPC) with regard to documents

D1: S Jain *et al.*, "Thin film layered structure for acousto-optic devices"; Journal of Physics D: Applied Physics, Vol. 25 (1992), No.7, GB; pages 1116 to 1121

D3: J K Srivastava *et al.*, "Electrical characteristics of lithium-doped ZnO films", Journal of the Electrochemical Society, Vol. 136 (1989), No. 11, US; pages 3414 to 3417.

The examining division found in particular that the claimed subject-matter differed from the acousto-optic light deflector device disclosed in document D1 only in the piezoelectric characteristics and the specific resistance and in the light propagation loss of the first and second piezoelectric films, and held that these features were rendered obvious by the general knowledge of the person skilled in the art and by the teaching of document D3 relating to the increased resistivity of lithium-doped ZnO.

II. In response to a telephone consultation with the rapporteur, the appellant filed by letter dated 1 April 2004 an amended set of claims 1 to 8 and amended description pages 1 to 3, 3a and 4 to 13, and requested that the decision under appeal be set aside and a patent be granted on the basis of the amended application documents together with the drawing sheets as originally filed.

III. Claim 1, the sole independent claim according to the appellant's request, is worded as follows:

" 1. An acousto-optic light deflector device (1) comprising:

    a substrate (2);

    a first piezoelectric thin film (3a) formed on the substrate (2) and an interdigital transducer (4) formed in contact with the first piezoelectric thin film (3a) to define a SAW generator region (5A), said interdigital transducer (4) being adapted to generate surface acoustic waves which are propagated through said first piezoelectric film along a propagation direction when an exciting voltage is applied thereto; and

    a second piezoelectric thin film (3b) formed on the substrate (2) including a light waveguide region (5B) which is positioned to receive surface acoustic waves generated by the interdigital transducer (4) and transmits light;

    the first piezoelectric thin film (3a) exhibiting better piezoelectric characteristics and higher specific resistance than the second piezoelectric thin film (3b), and the second piezoelectric thin film (3b)

exhibiting less light propagation loss than the first piezoelectric thin film (3a);

characterized in that

said first piezoelectric thin film (3a) is formed on a region of the upper surface of the substrate (2);

said second piezoelectric thin film (3b) is formed on the entire upper surface of the substrate (2) except for the region where the first piezoelectric thin film (3a) is formed."

IV. The arguments of the appellant in support of its requests can be summarised as follows:

The acousto-optic device described in document D1 with reference to Figure 2(b) comprises a thin film layered structure formed on a substrate. Considering the disclosure of the document without knowledge of the present invention and assuming the normal understanding a man of ordinary skill would have, the layered structure of the device is constituted by a film of  $\text{TeO}_2$  formed on the entire surface of the substrate and a film of  $\text{ZnO}$  formed on a portion of the  $\text{TeO}_2$  film. This film structure is different from the film structure defined in the characterising portion of claim 1. The examining division followed an *ex-post facto* analysis in interpreting the film layered structure of document D1 as being constituted by two films arranged side-by-side as claimed, this interpretation being in addition inconsistent with the disclosure of document D1 according to which the surface acoustic wave mainly propagates in the  $\text{ZnO}$  film and the light beam only propagates in the  $\text{TeO}_2$  film. In addition, while in document D1 only the portion of the wave penetrating into the  $\text{TeO}_2$  film interacts with the light beam in the

TeO<sub>2</sub> film, in the claimed device the entire surface acoustic wave effectively interacts with the light beam, thus improving the effectiveness in the interaction between the light beam and the surface acoustic wave. This results in an acousto-optic deflector with higher efficiency and better performance.

The prior art does not render obvious the claimed invention. In particular, document D3 discloses an interdigital transducer formed on a substrate including a single film of ZnO and is silent as to acousto-optic couplers, the document merely teaching doping the entire film to increase the resistance of the film.

### **Reasons for the Decision**

1. The appeal complies with the requirements mentioned in Rule 65(1) EPC and is therefore admissible.
  
2. The Board is satisfied that the application documents as amended according to the present request of the appellant comply with the formal requirements of the EPC. In particular, the examining division already found that claim 1 amended according to the second auxiliary request considered in the contested decision and corresponding, apart from minor amendments of a formal nature, to present claim 1 was admissible under Article 123(2) EPC. Furthermore, the description has been adapted to the set of amended claims (Article 84 EPC, second sentence, and Rule 27(1) EPC).

In addition, with the exception of the issue of inventive step, none of the substantive requirements of

the EPC, including novelty of the claimed invention, has been questioned by the examining division, and the Board sees no reason for a different finding.

Thus, the sole question to be considered is whether the Board is in a position to endorse the examining division's assessment of inventive step of the claimed subject-matter according to the problem-solution approach and to confirm the negative finding of the examining division in this respect.

3. *Closest prior art*

The Board concurs with the finding of the examining division that document D1 represents the closest state of the art with regard to the claimed invention. This document discloses an acousto-optic light deflector device comprising a substrate of Si covered by a layer of SiO<sub>2</sub>, and first and second piezoelectric thin films of ZnO and TeO<sub>2</sub>, respectively (abstract, paragraph bridging the two columns on page 1116, and Figure 2(b) together with the corresponding description in the first column of page 1118). The TeO<sub>2</sub> film is formed on the whole upper surface of the substrate and the ZnO film is formed on a portion of the first film, the device being designed so that light is transmitted through a light waveguide region of the TeO<sub>2</sub> film. The device further comprises an interdigital transducer (IDT in Figure 2(b)) formed on the ZnO film and arranged to generate surface acoustic waves (SAW) upon application of an exciting voltage, the film layered arrangement being such that the acoustic waves generated in the SAW generator region of the ZnO film propagate along the ZnO film, penetrate into the TeO<sub>2</sub>



film and are then directed towards the light waveguide region of the TeO<sub>2</sub> film where they interact with the light beam. In addition, the ZnO film exhibits better piezoelectric characteristics and higher specific resistance than the TeO<sub>2</sub> film, and the TeO<sub>2</sub> film exhibits less light propagation loss than the ZnO film (abstract, lines 26 to 35 of the first column on page 1116, last paragraph of the first column on page 1118, and Figure 6 and Tables 1 and 2 together with the corresponding discussion).

4. *Determination of the technical contribution of the invention over the closest prior art*

4.1 Determination of the distinguishing features

4.1.1 In its decision the examining division held that the piezoelectric film arrangement defined in claim 1 - and consisting of a first piezoelectric film formed on a region of the substrate surface and a second piezoelectric film formed on the substrate surface except in the region where the first film is formed - was anticipated by the film layered arrangement of the device disclosed in document D1, and concluded that the claimed subject-matter differed from the device disclosed in document D1 only in the piezoelectric characteristics and the specific resistance and in the light propagation loss of the two films.

The appellant has contested the examining division's finding as being based on an arbitrary definition of the first and second piezoelectric thin films, which resulted from an *ex-post facto* analysis of the

disclosure of document D1 inconsistent with the proper technical disclosure of the document.

4.1.2 In the assessment of inventive step according to the problem-solution approach knowledge of the invention and its effects is not only inevitable by the very nature of the assessment, but also necessary, in particular when proceeding to the identification of the closest prior art and to the determination of the technical contribution achieved by the invention over the prior art. However, as repeatedly stressed by the Boards of Appeal (see "Case Law of the Boards of Appeal", 4<sup>th</sup> ed, 2001, chapter I, section D-2), the primary purpose of the problem-solution approach is the objective assessment of inventive step and consequently any *ex-post facto* analysis, and in particular any conclusion going beyond what the skilled person would have objectively inferred, without the benefit of hindsight knowledge of the invention, from the prior art is of necessity at variance with a proper application of the problem-solution approach (see decision T 967/97, not published in OJ EPO, point 3.3 of the reasons). This applies not only to - among others - the determination of the closest prior art ("Case Law of the Boards of Appeal", *supra*, chapter I, sections D-3.3 and D-3.5), the formulation of the technical problem solved by the invention (*supra*, chapter I, section D-4.2), and the assessment of what would have been obvious to the skilled person in the light of the state of the art (*supra*, chapter I, section D-6.1), but also to the determination of the technical contribution of the invention to the prior art. Accordingly, the determination of the technical contribution achieved by the invention over the closest

state of the art requires an objective and technically meaningful and consistent comparison of the claimed combination of structural and functional features with the technical information conveyed to the skilled person by the closest state of the art (point 4.1.3 below). Any attempt to interpret the disclosure of the closest prior art so as to distort or misrepresent, based on hindsight knowledge of the invention, the proper technical teaching of the disclosure in such a way that it artificially meets specific features recited in the claim under consideration (point 4.1.4 below) must therefore fail, especially as this would risk unfairly and tendentiously concealing the technical contribution of the invention (point 4.2.2 below) and prejudice the subsequent objective determination of the technical problem solved by the claimed invention.

4.1.3 The light deflector device defined in claim 1 and the device disclosed in document D1 are both based on the principle according to which a surface acoustic wave (SAW) generated in a piezoelectric medium and propagating in the medium towards a light-transmitting medium having piezoelectric characteristics interacts with a light beam propagating in the light-transmitting medium so as to deflect the direction of propagation of the light beam. The objective assessment of the claimed subject-matter and of the disclosure of document D1 (point 3 above) shows that:

- the piezoelectric medium in which the SAW is generated and through which the SAW then propagates is constituted in claim 1 by the first piezoelectric thin film, i.e. the film in

which the SAW generator region determined by the interdigital transducer is defined and through which the SAW propagates, and in document D1 by the ZnO film, and

- the light-transmitting medium is constituted in claim 1 by the second piezoelectric thin film, i.e. the film in which the light waveguide region is formed and arranged to receive the SAW, and in document D1 by the TeO<sub>2</sub> film.

Accordingly, although a multi-film layered arrangement as that disclosed in document D1 may in principle be construed in different alternative ways depending on the structure of the layered arrangement and the characteristics and the function of the individual films, an objective and technically meaningful and consistent comparison of the structural and functional features of the claimed subject-matter with the proper technical information disclosed in document D1 clearly and unambiguously leads to identifying the ZnO film and the TeO<sub>2</sub> film of the device of document D1 as the counterpart of the first and the second piezoelectric films defined in claim 1, respectively.

- 4.1.4 The above assessment by the Board of the disclosure of document D1 differs from the corresponding assessment by the examining division (point 4.1.1 above). In arriving at its finding, the examining division interpreted the film arrangement disclosed in document D1 and consisting of the ZnO film formed on a portion of the TeO<sub>2</sub> film as comprising a first film constituted by the portion of the ZnO film adjacent the interdigital transducer and the underlying portion of

the TeO<sub>2</sub> film, and a second film constituted by the remaining portion of the ZnO film, the portion of the TeO<sub>2</sub> film underlying the latter, and the remaining portion of the TeO<sub>2</sub> film not covered by the ZnO film. In the Board's view, only hindsight knowledge of the invention would have suggested this artificial representation of the film layered arrangement of document D1. In addition, according to document D1 the SAW generation efficiency is determined by the features of the ZnO film (page 1116, first column, lines 26 to 35), and the refractive index of the TeO<sub>2</sub> film and the films above and below the TeO<sub>2</sub> film are such that the light is guided by, and confined within the TeO<sub>2</sub> film (page 1118, first column, lines 13 to 18); thus, according to the technical teaching of document D1 the TeO<sub>2</sub> film is not involved in the generation of the SAW and there is no light beam propagating through the ZnO film, and consequently the examining division's construction of a portion of the TeO<sub>2</sub> film and a portion of the ZnO film as constituting a portion of the SAW generator region and a portion of the light-transmitting waveguide region, respectively, constitute a misrepresentation of the technical teaching conveyed to the skilled person by the disclosure of the document.

- 4.1.5 In view of the above, the Board concludes that the claimed subject-matter differs from the disclosure of document D1 in that, while in document D1 the first film is formed on a portion of the second film which in turn is formed on the entire upper surface of the substrate, in the claimed device the first piezoelectric film is formed on the upper surface of the substrate and the second piezoelectric film is formed on the entire upper surface of the substrate

except for the region where the first piezoelectric film is formed as defined in the characterizing portion of the claim.

#### 4.2 Assessment of the technical effects

4.2.1 According to the description of the application as filed (page 2, last line to page 3, penultimate paragraph), it is difficult to select a material having excellent piezoelectric properties for generating surface acoustic waves and at the same time excellent light propagation characteristics for guiding and transmitting without loss the light beam, and the film patterned arrangement constituted by two films having the piezoelectric and light propagation characteristics as claimed solves the problem of providing an acousto-optic light deflector device that is highly efficient and excellent in performance (page 3, last paragraph to page 5, first paragraph, paragraph bridging pages 5 and 6, and second paragraph on page 12).

The acousto-optic light deflector device disclosed in document D1 also comprises an arrangement of two films each having the physical characteristics - although not the side-by-side arrangement - of the two films of the claimed device and therefore achieves - at least to some extent - the same effects as those achieved by the claimed invention (document D1, abstract, page 1116, first column, lines 26 to 35). Nonetheless, in accordance with the appellant's submissions while in document D1 of the SAW generated in the ZnO film and propagating through the film in the direction of the light waveguide region only the portion that penetrates in the underlying TeO<sub>2</sub> film is guided by the film

arrangement so as to propagate towards the light waveguide region and to interact with the light beam propagating through the light waveguide region (Figure 2(b)), in the claimed device substantially the entire SAW generated in, and propagating through the first film in the direction of the light waveguide region penetrates into the second film through the interface between the adjacent side edges of the two films and is guided by the second film towards the light waveguide region so as to interact with the light beam.

4.2.2 This difference in the SAW penetration mechanism through the interface of the two films - and which was concealed in the examining division's analysis of the disclosure of document D1, see point 4.1.4 above - supports in the Board's view the appellant's contention that the side-by-side arrangement of the films defined in the characterizing clause of the claim and distinguishing the claimed subject-matter from the device of document D1 improves the effectiveness in the interaction between the light beam and the SAW generated by the transducer, thus resulting in an acousto-optic deflector having a higher efficiency and better performance than that disclosed in document D1.

5. *Formulation of the technical problem*

It follows from the analysis in point 4.2 above that the problem originally addressed in the application has been solved by the device of document D1 only to a lower degree than in the claimed invention. Accordingly, the technical problem solved by the claimed invention with regard to the closest prior art can be seen in

further enhancing the efficiency and improving the performance of the acousto-optic light deflector device.

6. *Assessment of inventive step*

The skilled person confronted with the problem formulated above would consider the solutions proposed or suggested in the field as well as his own general knowledge. However, none of the available documents on file disclose or even suggest non-superposed piezoelectric film arrangements as that of the claimed invention. In particular, document D3 considered by the examining division in its decision only relates to the electrical characteristics of doped ZnO films used in the generation of SAW (abstract and Figure 1), and is silent as to the use of the SAW for deflecting a light beam, so that the document does not even address the problem formulated above. In addition, document D1 only discloses superposed arrangements of films (Figures 1, 2(a) and 2(b)) and emphasizes the role of the composite thickness of the superposed films (page 1118, first column, lines 31 to 35, and page 1120, last paragraph) in ensuring the penetration of the SAW generated in one film into the underlying film, and in the Board's view the skilled person would have refrained from considering - let alone from conceiving using his own general knowledge - alternative film arrangements that depart from the superposed layered film arrangement disclosed in the document.

Accordingly, in the Board's view neither the available prior art nor the common general knowledge of the skilled person render obvious the claimed device and



therefore the subject-matter of claim 1 involves an inventive step within the meaning of Article 56 EPC.

7. Dependent claims 2 to 8 concern particular embodiments of the subject-matter of claim 1 and meet therefore also the requirements of patentability mentioned in Article 52(1) EPC.
  
8. In view of the above conclusions and considerations, and having convinced itself that the patent application as amended according to the appellant's request and the invention to which it relates meet the requirements of the EPC (Article 97(2) EPC), the Board, in accordance with Article 111(1) EPC, considers it appropriate to exercise favourably the power within the competence of the examining division to order grant of a patent.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.
  
2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the following application documents:
  - claims 1 to 8 filed with the letter dated 1 April 2004,
  
  - description pages 1 to 3, 3a and 4 to 13 filed with the letter dated 1 April 2004, and
  
  - drawing sheets 1/3 to 3/3 as originally filed.

The Registrar:

The Chairman:

P. Martorana

A. G. Klein